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Target braking system in GPS networks

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***Abstract* - The paper describes the new principles of mathematical modeling of braking train, the accuracy of the mathematical model, the principles of calculating the parameters of the train braking, using the Global Positioning System.**
In rabotedaetsya mathematical model of inhibition, taking into account the distribution of mass trains, examines the influence of the mass of the locomotive, mass loaded and empty cars on the process of braking trains using Global Positioning System .. We consider the existing principles of calculating the programmed trajectory of the train, the existing method of calculating devices, software for modeling the curve of the train in the mode of inhibition, using the Global Positioning System ..
In this paper we give a method to develop a new model for management control of braking systems of trains using the GPS.

INTRODUCTION

Train braking mathematical model reflects the physical processes operating at the time the train brakes, allows to calculate and construct the trajectory of train braking mode. To stop the train at a certain place, take into account various factors, which operates the train. Automatic Train Control braking process in the case of mathematical models accurately reflect the train is in motion the current reality.
Also at the train stopping the development of mathematical models take into account factors such as freight and passenger train lengths, the alignment dependence of the fracture relief, weight train along the length of the partition, taking into account the actual road profile, the transitional processes during braking, which provides real-braking distance bias from the expected. Train braking system modeling should take into account the braking control features depending on the type and brake type.

I PROBLEM FORMULATIONS

The challenge to identify deviations from the train mathematical model is needed to determine the changes in train the initial conditions, taking into account the weight of the train, road profiles, etc. conditions, this task can be solved using the methods of sensitivity theory. Consequently, the abnormal function of the general form can be expressed as follows:

$$\partial X = \frac{\partial X}{\partial \alpha_1}\alpha_1 + \frac{\partial X}{\partial \alpha_2} + \partial \alpha_2 ... + \frac{\partial X}{\partial \alpha_n}\partial \alpha_n \quad (1)$$

Where:
X - number of variables $\alpha_1, \alpha_2, ..., \alpha_n$ function;
∂X - unknown function of variance;;
$\frac{\partial X}{\partial \alpha_i}$ - partial derivative functions;
$\partial \alpha_i$ - variable deviation.

Train Running Differential Equation:

$$a = -\zeta \cdot f_z \quad (2)$$

Where:
$a = \frac{\partial v}{\partial t}$ - train acceleration ;
ζ - Train acceleration with a force equal to the solitary.

Stopping a mathematical model, with a train of mass distribution:

$$\frac{dv}{dt} = -\zeta\left[\frac{B(t,v)+W(v)}{G} + \frac{1}{l_v}(l_v - s_0)i_1 + \frac{1}{l_v}\sum_{j=2}^{m-1} s_j l_j + \frac{1}{l_v}(s_0 - \sum_{j=2}^{m-1} s_j) i_m\right] \quad 3)$$

Where:
ζ - train acceleration;
B(t,v) – braking force;
W - basic resistance strength train movements;
l_v - train length ;
G - weight of the train;
s_0 - the distance from origin;
i_j - j-travel element of the gradient;
s_j - j-travel element of the gradient;.

Constraints:

$$t_0 < T^* < T_{Braking} \quad (4)$$

When:

$$V(t_{0+1}) = V(t_0)a\,; \quad (5)$$

Where:

$$0{,}6 < a < 0{,}8 m/sek^2; \quad \ldots. \tag{6}$$

Stopping distance consists of the preparation and real-stages:

$$S_T = S_P + S_D; \tag{7}$$

Where:
the preparatory phase:

$$S_P = 0278 v_0 t_p; \tag{8}$$

real phase:

$$S_D = \sum \frac{500\left(v_N^2 - v_K^2\right)}{\zeta\left(1000\vartheta_P \cdot \varphi_{kp} + \omega_{Ox} + i_C\right)}; \tag{9}$$

v_0 - train speed braking at the beginning;

v_N - initial velocity range;

v_N - end of speed range;

ζ_K - slowing down the train;

φ_{KP} -the estimated coefficient of friction;

ω_{Ox} - specific resistance of a train idling mode;

i_C - specific resistance is adjusted travel time.

Brake preparation time t_p:

Freight train with the axes 200 and less::

$$t_p = 7 - \frac{10 i_C}{1000\vartheta_P \varphi_{KP}}. \tag{10}$$

Freight train with the axes 200 and more:

$$t_p = 10 - \frac{15 i_C}{1000\vartheta_P \varphi_{KP}}. \tag{11}$$

Freight train with the axes 300 and more:

$$t_p = 12 - \frac{18 i_C}{1000\vartheta_P \varphi_{KP}}. \tag{12}$$

Passenger trains with air brakes:

$$t_p = 4 - \frac{5 i_C}{1000\vartheta_P \varphi_{KP}}. \tag{13}$$

Passenger train with electro brakes:

$$t_p = 2 - \frac{3 i_C}{1000\vartheta_P \varphi_{KP}}. \tag{14}$$

Since the time interval of the braking force and the specific resistance of the train movement is taken as constant, the speed increase can be estimated from the expression:

$$\Delta v = \frac{\xi\left(b_T + \omega_{Ox} + i_c\right)\Delta t}{3600}. \tag{15}$$

Brake distance:

$$\Delta S_T = \frac{\Delta t v_{vid}}{3{,}6}; \tag{16}$$

Where:

v_{vid} - The average speed of the estimated range.

So the totalbrake distance:

$$S = \sum \Delta S_T. \tag{17}$$

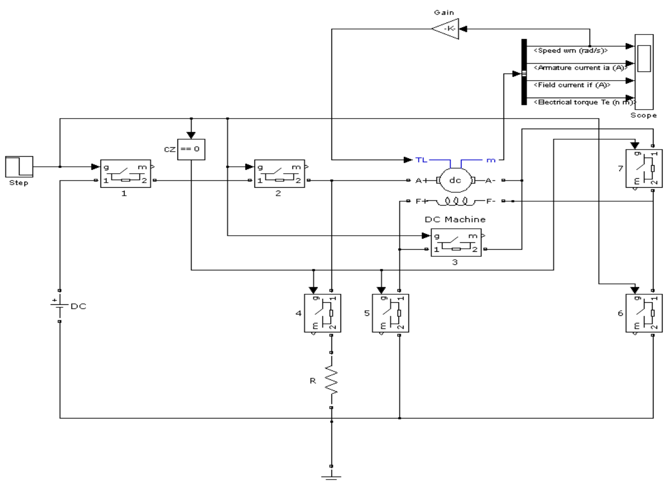


Fig.1.The scheme of DC motor regenerative braking in Simulink

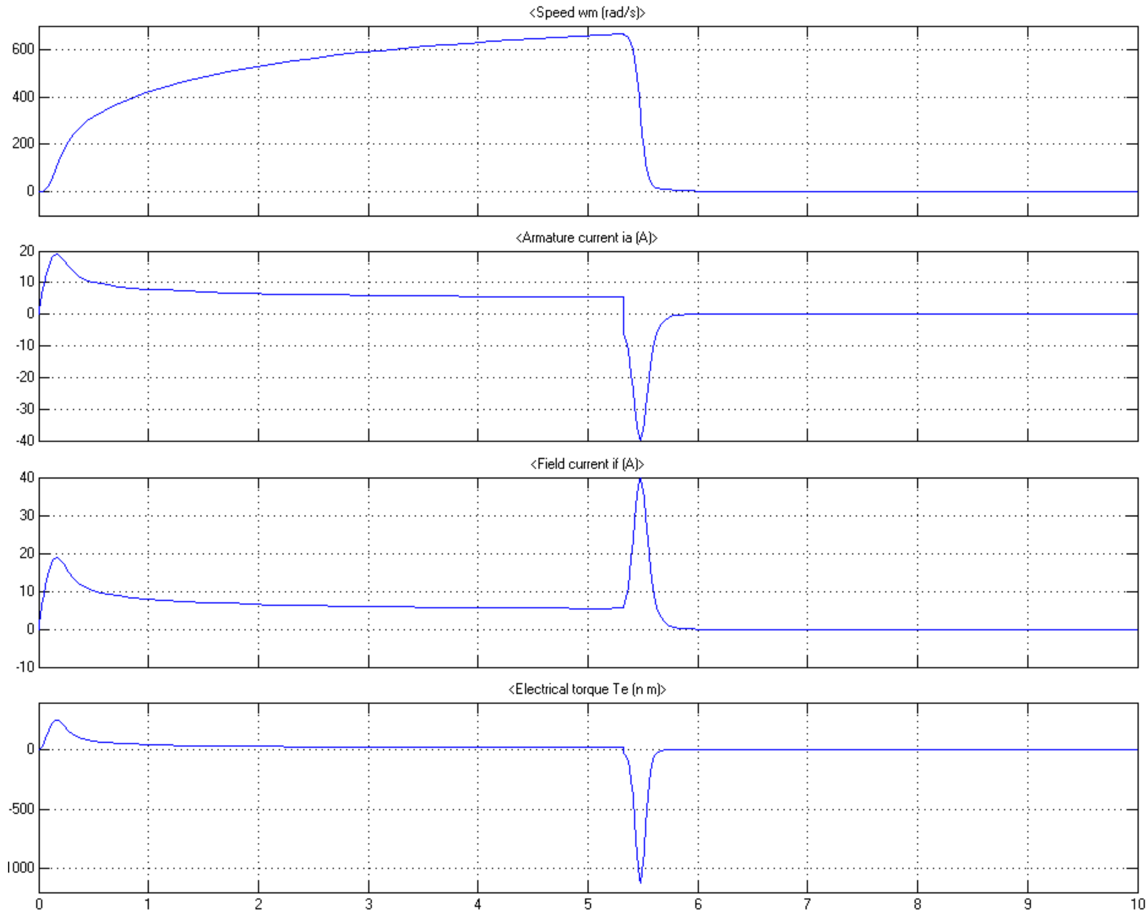


Fig.2. DC motor brake diagrams in Simulink

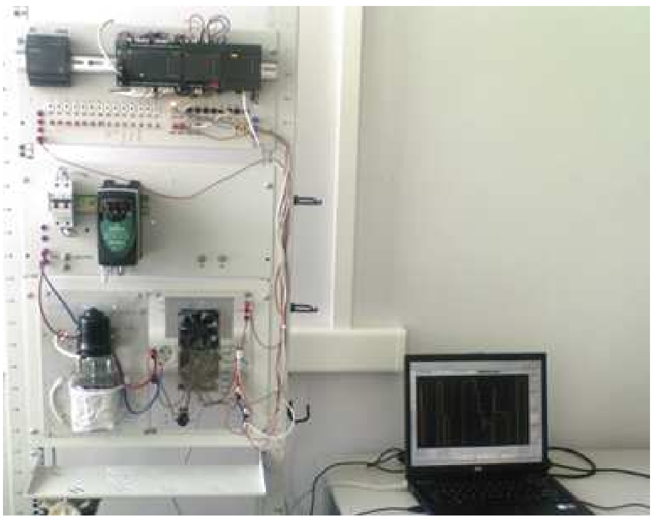


Fig 3. General view of experimental stand based on the controller Simatic CPU224 Siemens

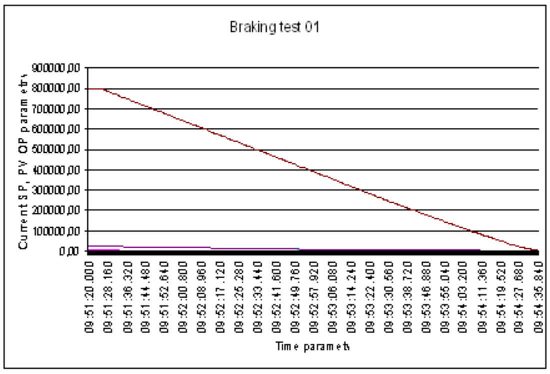
THE PRACTICAL EXPERIMENT

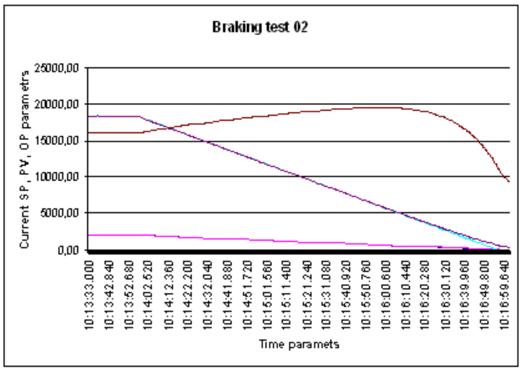
For a practical experiment to study the process of braking the electric motor and the dependence of its heat from the braking current stand was used, consisting of the following sites:

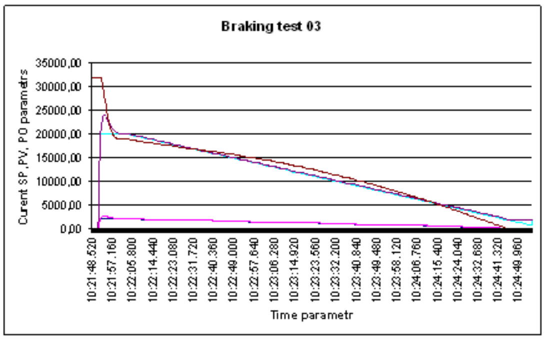
1. Industrial controller Simatic CPU224 Siemens
2. Ethernet interface module CP343-1
3. Analog-digital conversion module EM235
4. LOGO! Power
5. Frequency converter Emerson Commander SK
6. Asynchronous motor КД-50-У4
7. Generator ПТ М3 236
8. Computer XP510
9. Protective machines GE G61

Software products needed for the research:

1. Step7 MicroWin 4.0.6 (Software for controllers Siemens 200-series)
2. PCAccess 1.0.3 (OPC Server Software for controllers Siemens 200-series)
3. CitectSCADA 6.10 (SCADA)
4. Microsoft Office Excel 2003







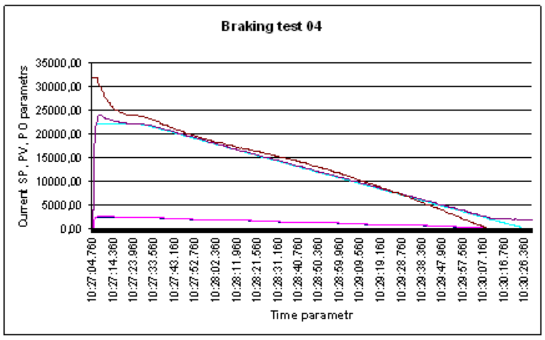


Fig.4. Experimental graphs of brakes tests.

Conclusions

Determining the location of trains based of data from the Satellite Position System provides high accuracy in calculating the coordinates of the train speed and direction of motion, increases the effectiveness of control systems for traffic safety. The system allows to control the targeting inhibition of the train with a given accuracy.

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Uteševs I., Levčenkovs A. Vilciena mērķbremzēšanas sistēma izmantojot GPS tīklu

Darbā aprakstīti jaunie principi matemātiskās modelēšanas vilcienu bremzēšanas režīmos, precizitāti matemātisko modeli, vilcienu bremzēšanas parametru aprēķina principi izmantojot Globālo Pozicionēšanas Sistēmu.
Darbā aprakstīts matemātiskais vilcienu bremzēšanas modelis ņemot vērā masveida vilcienu izplatīšanu, lokomotīva masu, piekrauto un tukšo vagonu masas ietekmi

uz vilciena bremzēšanas procesu izmantojot Globālās Pozicionēšanas Sistēmu.
Darbā aprakstīti pašreizējie vilciena bremzēšanas trajektoriju aprēķinu principi, esošās programmu ierīces aprēķināšanas metodi izmantojot Globālās Pozicionēšanas Sistēmu. Rakstā ir dota metode vilciena bremžu sistēmas kontroles jauno modeļu izveidošanai izmantojot Globālās Pozicionēšanas Sistēmu.

Утешев И., ЛевченковА. Система прицельного торможения поезда с использованием сети GPS

В работе даются новые принципы математического моделирования торможения поездов, точность математической модели, принципы расчета параметров торможения поезда, с помощью Глобальной Системы Позиционирования.
В статье описывается математической моделью торможения, с учетом распределения массы поезда, рассматривается влияние массы локомотива, массы груженых и порожних вагонов на процесс торможения поезда с помощью Глобальной Системы Позиционирования. В работе описаны существующие принципы расчета программированной траектории поезда, существующая методика расчета программного устройства для моделирования кривых движения поезда в режиме торможения используя Глобальную Систему Позиционирования.
В этой статье дается метод для разработки новой модели управления для управления тормозными системами поездов с помощью системы GPS.